

## Sup/IRBuck™

### USER GUIDE FOR IRDC3891 EVALUATION BOARD

#### DESCRIPTION

The IR3891 is a dual synchronous buck converter, providing a compact, high performance and flexible solution in a small 5mm X 6mm Power QFN package.

Key features offered by the IR3891 include internal Digital Soft Start, precision 0.5V reference voltage, Power Good, thermal protection, programmable switching frequency, Enable input, input under-voltage lockout for proper start-up, enhanced line/load regulation with feed forward, external frequency synchronization with smooth clocking, internal LDO, pre-bias start-up,

output over voltage protection as well as open feedback line protection.

Output over-current protection function is implemented by sensing the voltage developed across the on-resistance of the synchronous rectifier MOSFET for optimum cost and performance and the current limit is thermally compensated.

This user guide contains the schematic and bill of materials for the IRDC3891 evaluation board. The guide describes operation and use of the evaluation board itself. Detailed application information for IR3891 is available in the IR3891 data sheet.

#### BOARD FEATURES

- $V_{in} = +12.0V$
- $F_s = 600kHz$
- $V_{out1} = +1.8V @ 4A$
- $L_1 = 2.2\mu H$
- $C_{out1} = 4 \times 22\mu F$  (ceramic 0805)
- $C_{in} = 4 \times 10\mu F$  (ceramic 1206) +  $1 \times 330\mu F$  (electrolytic)

$$V_{out2} = +1.2V @ 4A$$

$$L_2 = 1.5\mu H$$

$$C_{out2} = 4 \times 22\mu F \text{ (ceramic 0805)}$$

## CONNECTIONS and OPERATING INSTRUCTIONS

A well regulated +12.0V input supply should be connected to VIN+ and VIN-. A maximum 4A load should be connected to VOUT+ and VOUT-. The connection diagram is shown in Fig. 1 and inputs and outputs of the board are listed in Table I.

IR3891 has only one input supply and internal LDO generates Vcc from Vin. If operation with external Vcc is required, then R3 should be removed and external Vcc should be applied between Vcc+ and Vcc- pins. Vin pin (input of the LDO) and Vcc/LDO pins should be shorted together (populate R4) for external Vcc operation.

The output of channel2 (Vout<sub>2</sub>) can follow the voltage at the Seq pin. For this purpose, The value of R5 and R6 can be selected to provide the desired sequencing ratio between Seq input and Vout<sub>2</sub>. For normal operation (non-sequencing) Seq pin should be left floating. Seq pin is internally pulled up to 3.3V.

**Table I. Connections**

| Connection | Signal Name                  |
|------------|------------------------------|
| VIN+       | PV <sub>in</sub> (+12V)      |
| VIN-       | Ground of PV <sub>in</sub>   |
| VOUT1+     | V <sub>out1</sub> (+1.8V)    |
| VOUT1-     | Ground of Vout <sub>1</sub>  |
| VOUT2+     | V <sub>out2</sub> (+1.2V)    |
| VOUT2-     | Ground of Vout <sub>2</sub>  |
| VCC+       | VCC/LDO pin                  |
| VCC-       | Connected to PGND            |
| VSEQ       | Sequence input               |
| EN1, EN2   | Enable input of each channel |
| Sync       | Synchronous input            |

## LAYOUT

The PCB is a 4-layer board. All of layers are 2 Oz. copper. The IR3891 and other components are mounted on the top and bottom side of the board.

Power supply decoupling capacitors, the Bootstrap capacitor and feedback components are located close to IR3891. The feedback resistors are connected to the output voltage at the point of regulation and are located close to IR3891. To improve efficiency, the circuit board is designed to minimize the length of the on-board power ground current path.

Connection Diagram

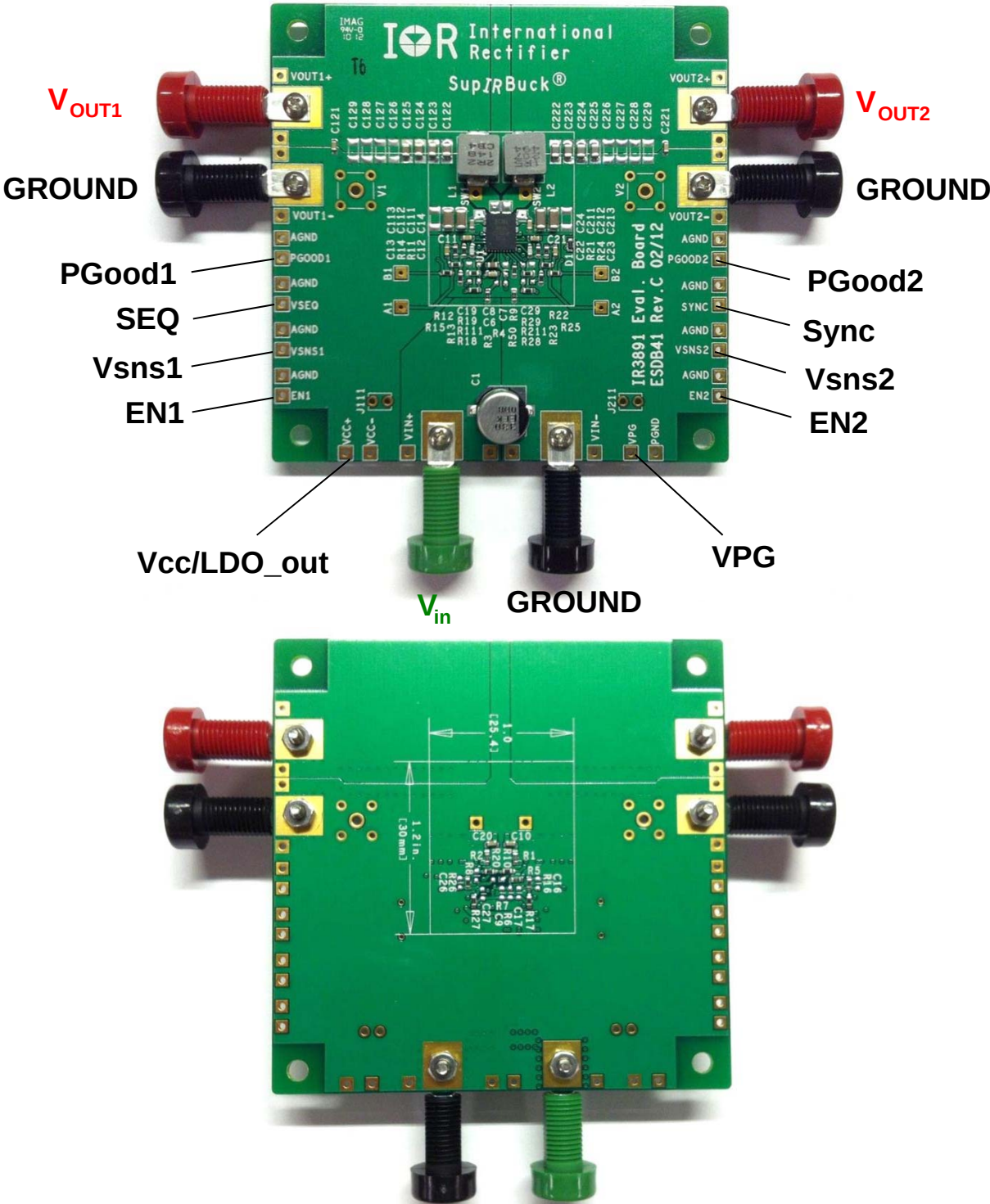


Fig. 1: Connection diagram of IRDC3891 evaluation board (top and bottom)

R50 is the  
Single point  
connection  
between AGND  
and PGND.

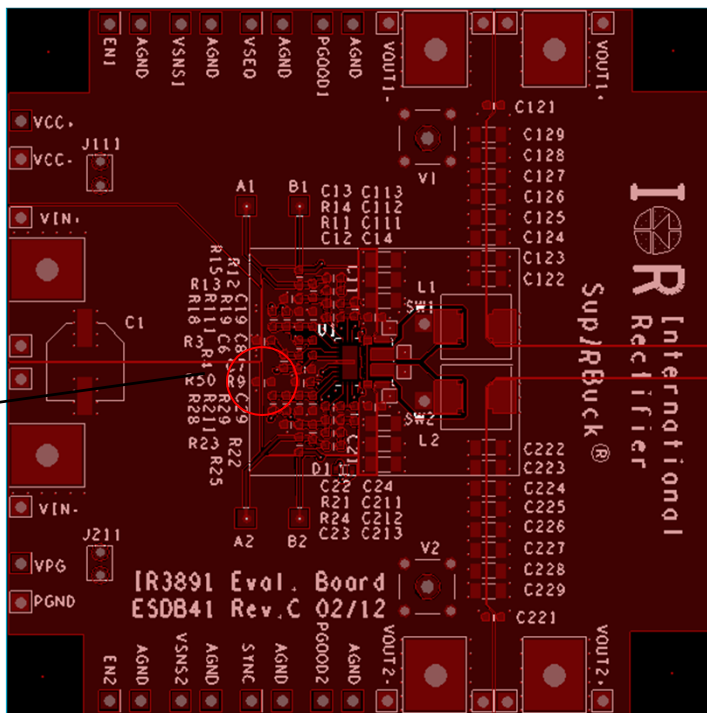


Fig. 2: Board layout, top layer

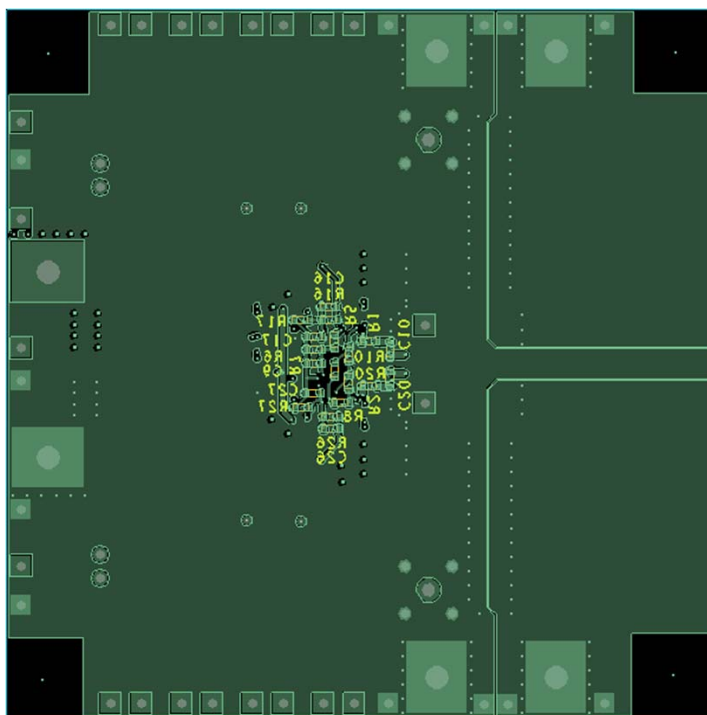


Fig. 3: Board layout, bottom layer

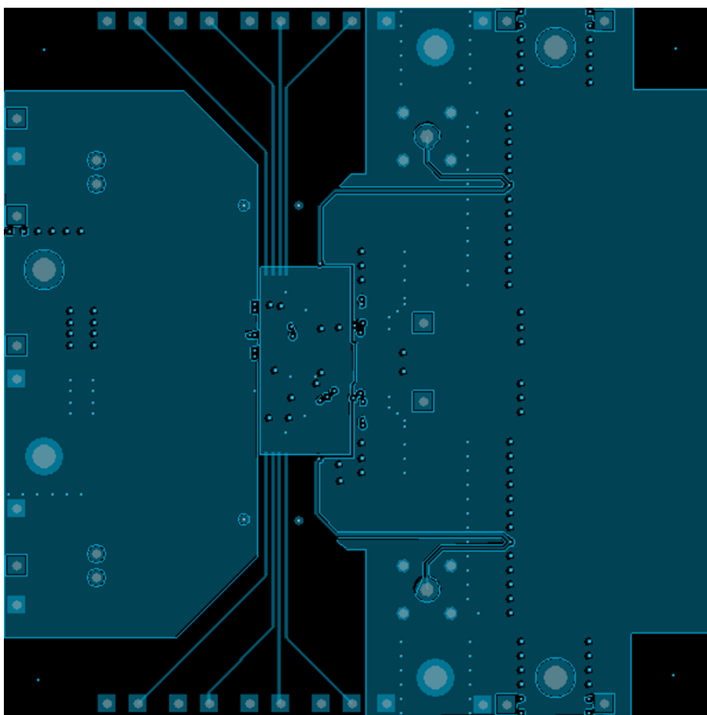


Fig. 4: Board layout, mid-layer I

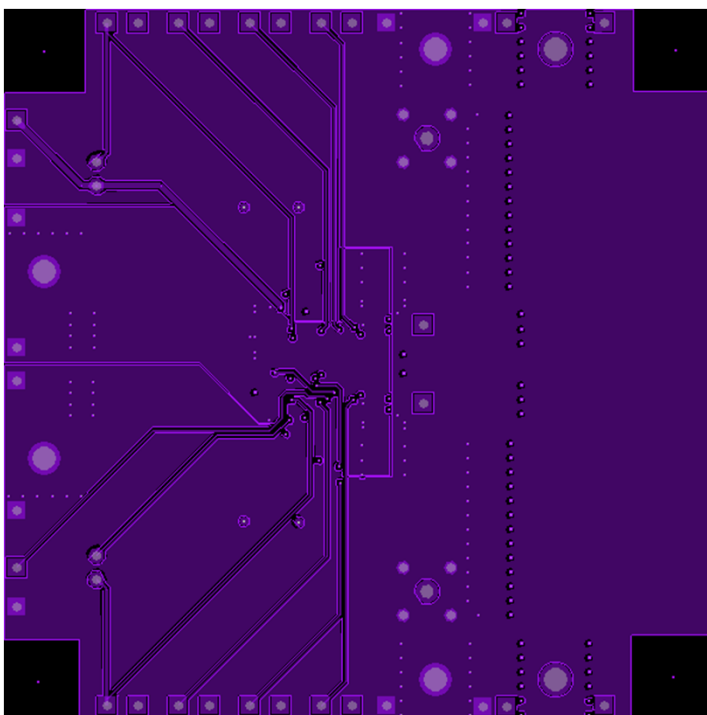
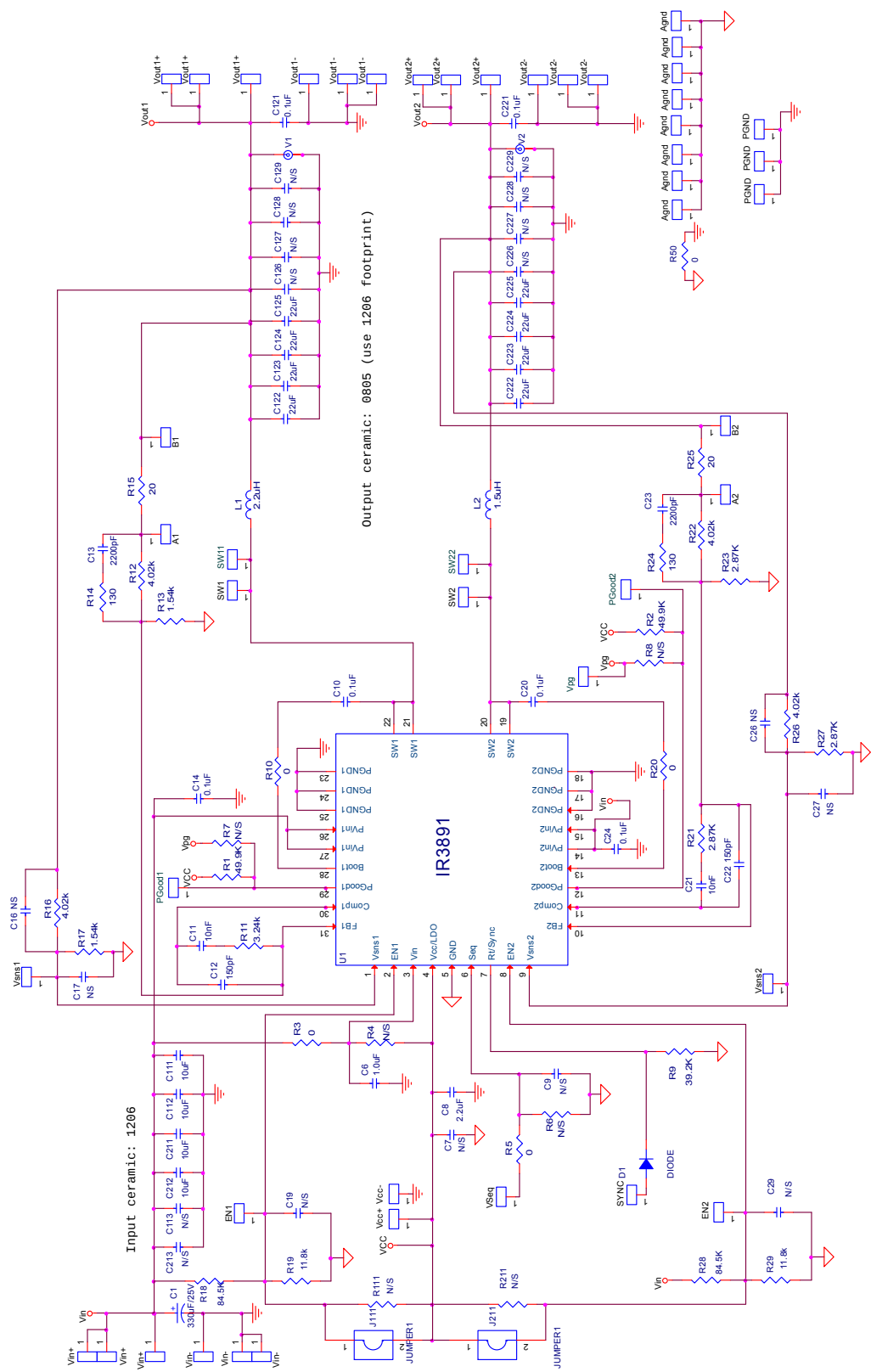


Fig. 5: Board layout, mid-layer II



**Fig.6: Schematic of the IRDC3891 evaluation board**

**Bill of Materials**

| Vin=12.0V, Vout1=1.8V/4A, Vout2=1.2V/4A, Fsw=600KHz |     |                                         |        |                                 |                         |                    |
|-----------------------------------------------------|-----|-----------------------------------------|--------|---------------------------------|-------------------------|--------------------|
| Item                                                | Qty | Part Reference                          | Value  | Description                     | Manufacturer            | Part Number        |
| 1                                                   | 1   | C1                                      | 330uF  | SMD Electrolytic F size 25V 20% | Panasonic               | EEV-FK1E331P       |
| 2                                                   | 4   | C111 C112 C211 C212                     | 10uF   | 1206, 25V, X5R, 10%             | TDK                     | C3216X5R1E106K     |
| 3                                                   | 1   | C6                                      | 1.0uF  | 0603, 25V, X5R, 10%             | Murata                  | GRM188R61E105KA12D |
| 4                                                   | 1   | C8                                      | 2.2uF  | 0603, 16V, X5R, 20%             | TDK                     | C1608X5R1C225M     |
| 5                                                   | 6   | C10 C14 C20 C24 C121 C221               | 0.1uF  | 0603, 25V, X7R, 10%             | Murata                  | GRM188R71E104KA01B |
| 6                                                   | 1   | C11                                     | 10nF   | 0603, 50V, X7R, 10%             | Murata                  | GRM188R71H103KA01B |
| 7                                                   | 1   | C12                                     | 150pF  | 0603, 50V, NP0, 5%              | Murata                  | GRM1885C1H151JA01D |
| 8                                                   | 2   | C13 C23                                 | 2200pF | 0603, 50V, X7R, 10%             | Murata                  | GRM188R71H222KA01B |
| 9                                                   | 1   | C21                                     | 10nF   | 0603, 50V, X7R, 10%             | Murata                  | GRM188R71H103KA01B |
| 10                                                  | 1   | C22                                     | 150pF  | 0603, 50V, NP0, 5%              | Murata                  | GRM1885C1H151JA01D |
| 11                                                  | 8   | C122 C123 C124 C125 C222 C223 C224 C225 | 22uF   | 0805, 6.3V, X5R, 20%            | TDK                     | C2012X5R0J226M     |
| 12                                                  | 1   | L1                                      | 2.2uH  | SMD 7.05x6.6x4.8mm, 11.2mΩ      | Cyntec                  | PCMB065T-2R2MS     |
| 13                                                  | 1   | L2                                      | 1.5uH  | SMD 7.05x6.6x4.8mm, 6.0mΩ       | Cyntec                  | PCMB065T-1R5MS     |
| 14                                                  | 2   | R1 R2                                   | 49.9K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF4992V      |
| 15                                                  | 5   | R3 R5 R10 R20 R50                       | 0      | Thick Film, 0603, 1/10W         | Panasonic               | ERJ-3GEY0R00V      |
| 16                                                  | 1   | R9                                      | 39.2K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF3922V      |
| 17                                                  | 1   | R11                                     | 3.24K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF3241V      |
| 18                                                  | 2   | R12 R16                                 | 4.02K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF4021V      |
| 19                                                  | 2   | R13 R17                                 | 1.54K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF1541V      |
| 20                                                  | 1   | R14                                     | 130    | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF1300V      |
| 21                                                  | 2   | R15 R25                                 | 20     | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF20R0V      |
| 22                                                  | 2   | R18 R28                                 | 84.5K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF8452V      |
| 23                                                  | 2   | R19 R29                                 | 11.8K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF1182V      |
| 24                                                  | 1   | R21                                     | 2.87K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF2871V      |
| 25                                                  | 2   | R22 R26                                 | 4.02K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF4021V      |
| 26                                                  | 2   | R23 R27                                 | 2.87K  | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF2871V      |
| 27                                                  | 1   | R24                                     | 130    | Thick Film, 0603, 1/10W, 1%     | Panasonic               | ERJ-3EKF1300V      |
| 28                                                  | 2   | J111 J211                               | jumper | This is a simple jumper         |                         |                    |
| 29                                                  | 1   | D1                                      |        | Schottky, 40V, SOD-523          | Vishay                  | BAS40-02VGS08      |
| 30                                                  | 1   | U1                                      | IR3891 | PQFN 5x6mm                      | International Rectifier | IR3891MPBF         |

## TYPICAL OPERATING WAVEFORMS

$V_{in}=12.0V$ ,  $V_{cc}/LDO=5.3V$ ,  $V_{out1}=1.8V$ ,  $V_{out2}=1.2V$ ,  $I_{o1}=I_{o2}=0-4A$ , Room Temperature, No air flow

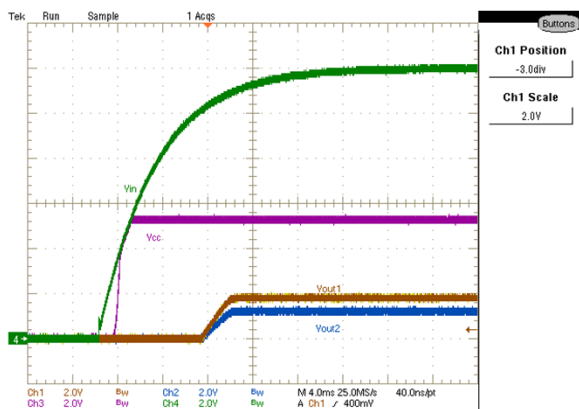


Fig. 7: Start up at 4A Load (Note 1)  
Ch<sub>1</sub>:V<sub>out1</sub>, Ch<sub>2</sub>:V<sub>out2</sub>, Ch<sub>3</sub>:V<sub>cc</sub>/LDO, Ch<sub>4</sub>:V<sub>in</sub>

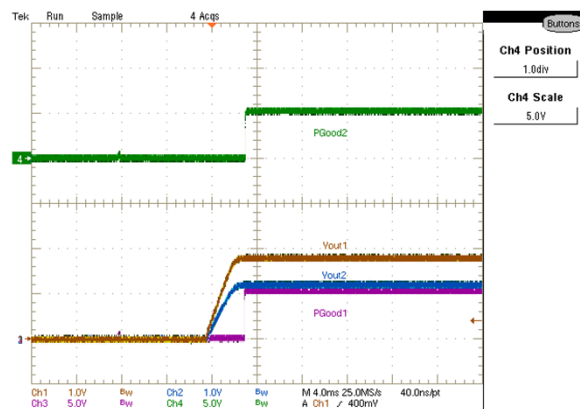


Fig. 8: Start up at 4A Load (Note 1)  
Ch<sub>1</sub>:V<sub>out1</sub>, Ch<sub>2</sub>:V<sub>out2</sub>, Ch<sub>3</sub>:PGood<sub>1</sub>, Ch<sub>4</sub>:PGood<sub>2</sub>

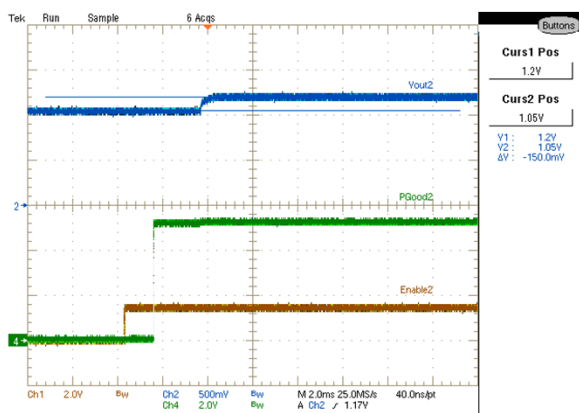


Fig. 9: Start up with 1.05V Prebias, 0A Load  
Ch<sub>1</sub>:Enable<sub>2</sub>, Ch<sub>2</sub>:V<sub>out2</sub>, Ch<sub>4</sub>:PGood<sub>2</sub>

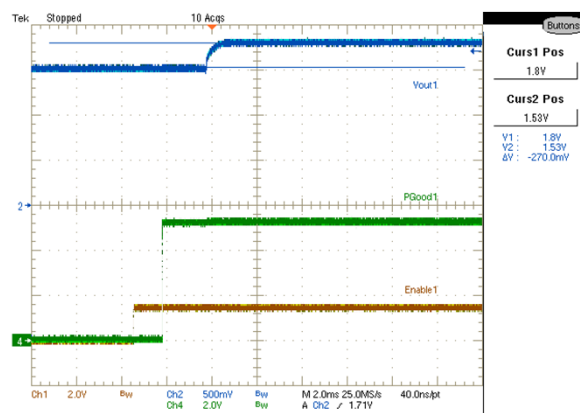


Fig. 10: Start up with 1.52V Prebias, 0A Load  
Ch<sub>1</sub>:Enable<sub>1</sub>, Ch<sub>2</sub>:V<sub>out1</sub>, Ch<sub>4</sub>:PGood<sub>1</sub>

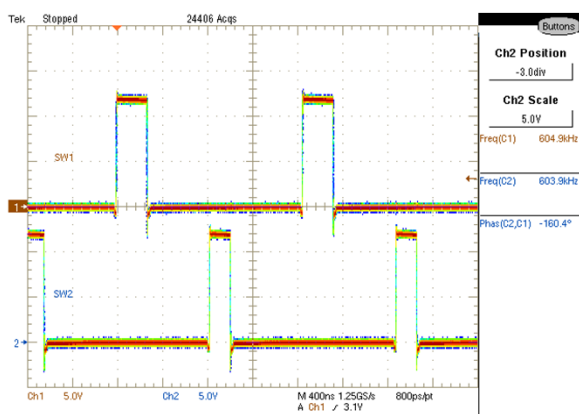


Fig. 11: Inductor switch node at 4A load / Channel  
Ch<sub>1</sub>:SW<sub>1</sub>, Ch<sub>2</sub>:SW<sub>2</sub>

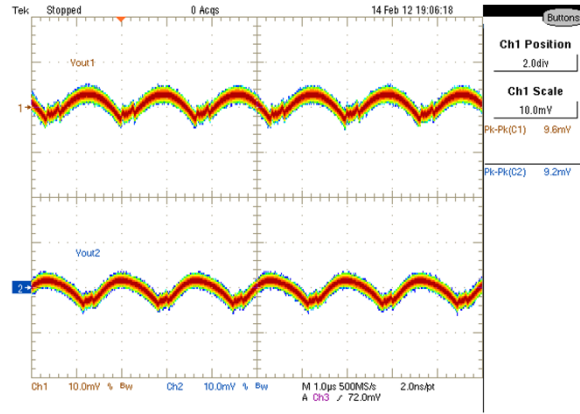


Fig. 12: Output Voltage Ripple, 4A load/channel (Note2)  
Ch<sub>1</sub>: V<sub>out1</sub>, Ch<sub>2</sub>: V<sub>out2</sub>

## TYPICAL OPERATING WAVEFORMS

$V_{in}=12.0V$ ,  $V_{cc}/LDO=5.3V$ ,  $V_{out1}=1.8V$ ,  $V_{out2}=1.2V$ , Room Temperature, No air flow

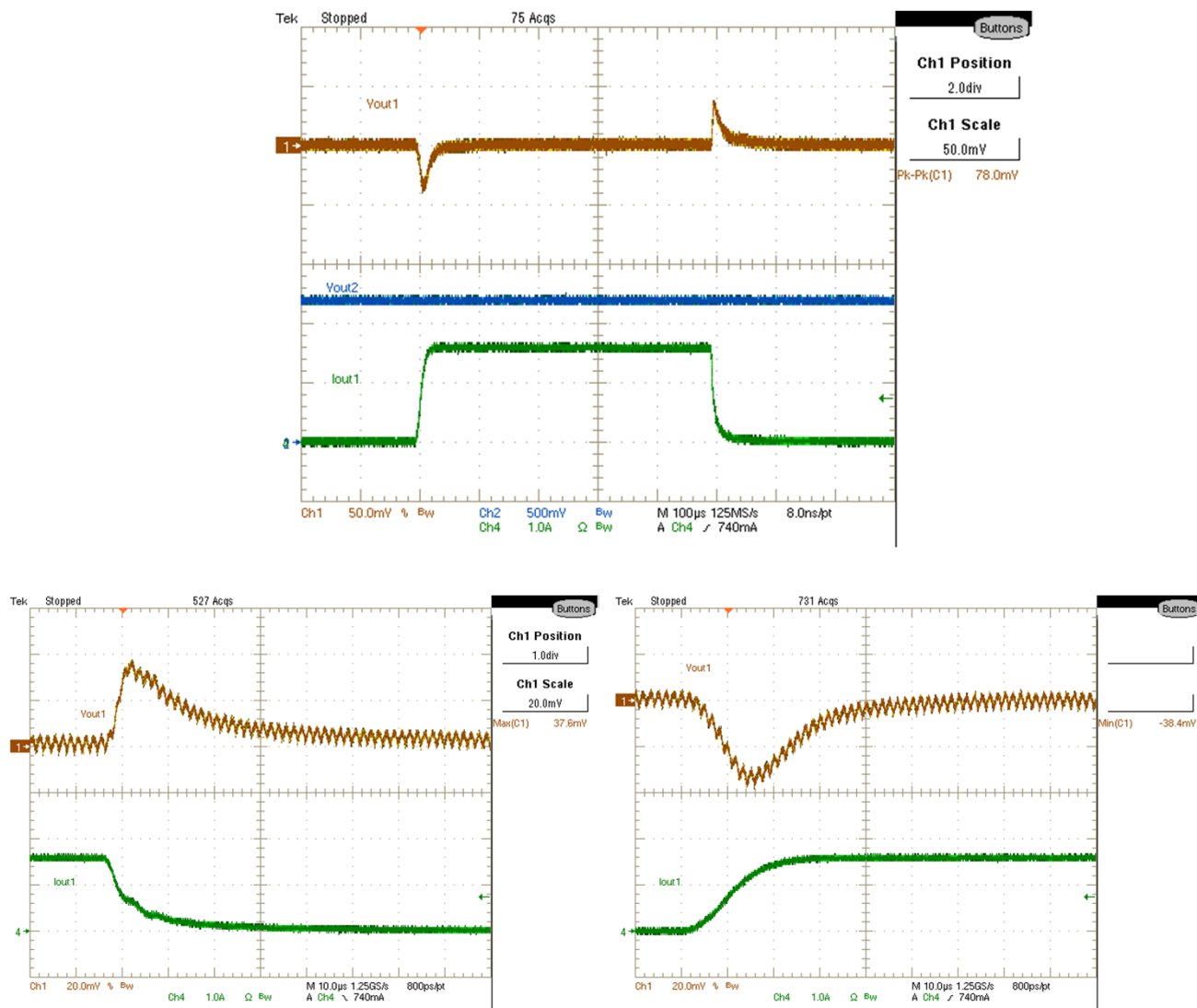


Fig. 15: Transient Response of channel1  
0A-1.6A (0-40%), Ch<sub>1</sub>: $V_{out1}$ , Ch<sub>2</sub>: $V_{out2}$ , Ch<sub>4</sub>: $I_{out1}$

## TYPICAL OPERATING WAVEFORMS

$V_{in}=12.0V$ ,  $V_{cc}/LDO=5.3V$ ,  $V_{out1}=1.8V$ ,  $V_{out2}=1.2V$ , Room Temperature, No air flow

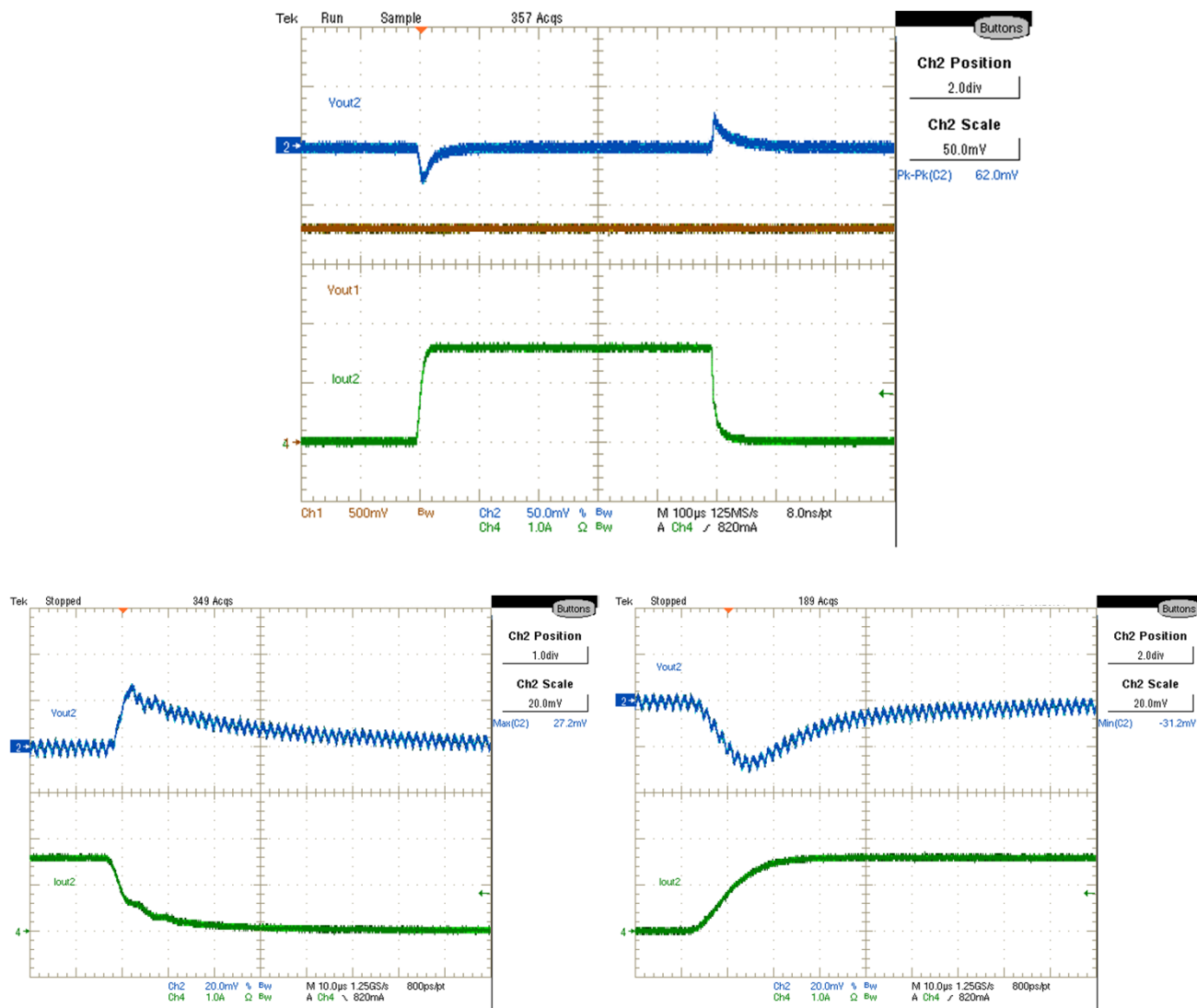


Fig. 16: Transient Response of channel2  
0A-1.6A (0-40%), Ch<sub>1</sub>: $V_{out1}$ , Ch<sub>2</sub>: $V_{out2}$ , Ch<sub>4</sub>:  $I_{out2}$

Note1: Enable is tied to  $V_{in}$  via a resistor divider.

Note2:  $V_o$  ripple signal is taken across C125 and C225 capacitors.

**Bode Plot, Channel1**  
**Vin=12.0V, Vcc/LDO=5.3V, Vout<sub>1</sub>=1.8V, Vout<sub>2</sub>=1.2V, I<sub>o1</sub>= I<sub>o2</sub>=4A, Room Temperature, No air flow**

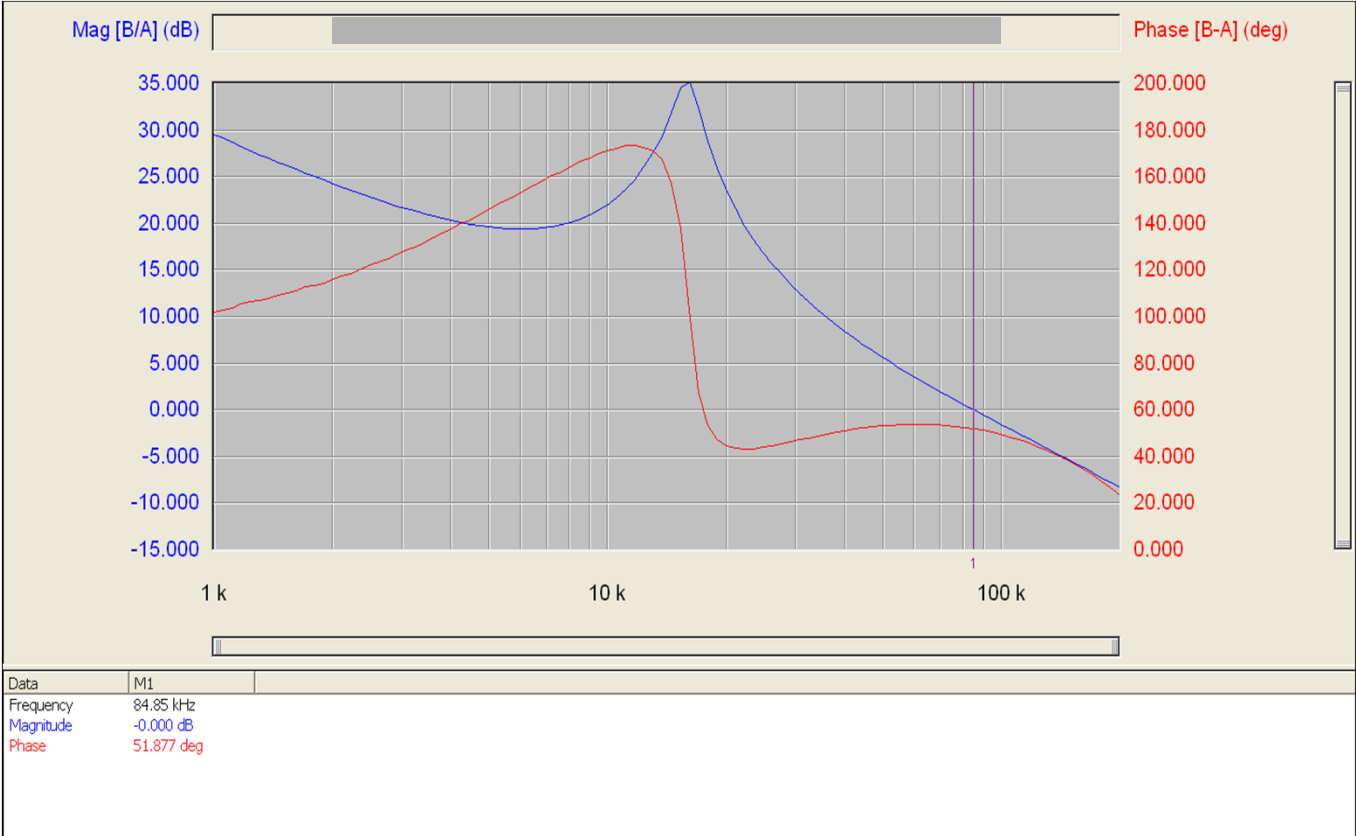


Fig.17: Bode Plot of CH1 at 4A load: Fo = 84.85 kHz; Phase Margin = 51.88°

**Bode Plot, Channel2**

Vin=12.0V, Vcc/LDO=5.3V, Vout<sub>1</sub>=1.8V, Vout<sub>2</sub>=1.2V, I<sub>o1</sub>= I<sub>o2</sub>=4A, Room Temperature, No air flow

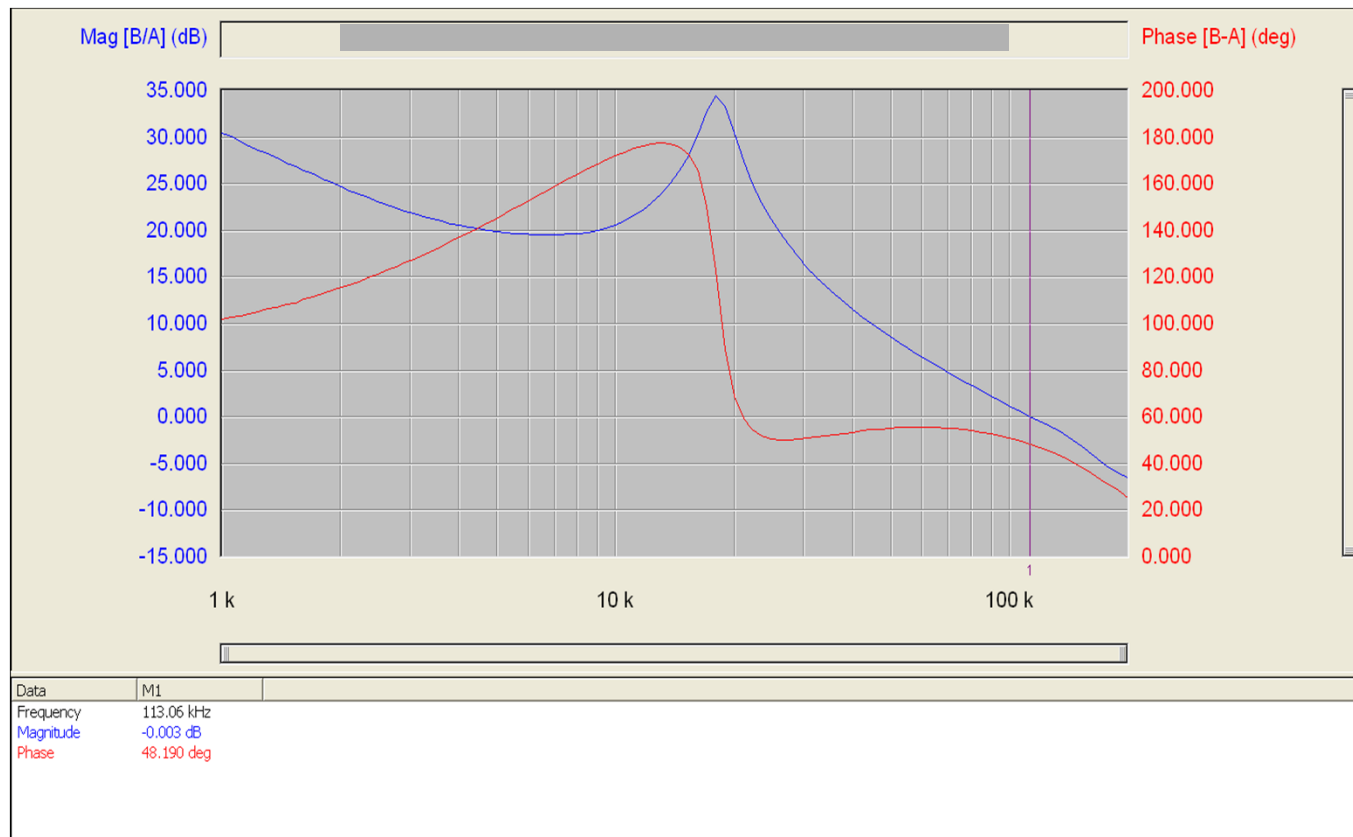


Fig.18: Bode Plot of CH2 at 4A load: Fo = 113.06 kHz; Phase Margin = 48.19°

Efficiency and Power Loss of channel1

$V_{in}=12.0V$ ,  $V_{cc}/LDO=5.3V$ ,  $V_{out1}=1.8V$ ,  $V_{out2}$  is disabled (EN2=low),  $I_{o1}= 0-4A$ , Room Temperature, No air flow

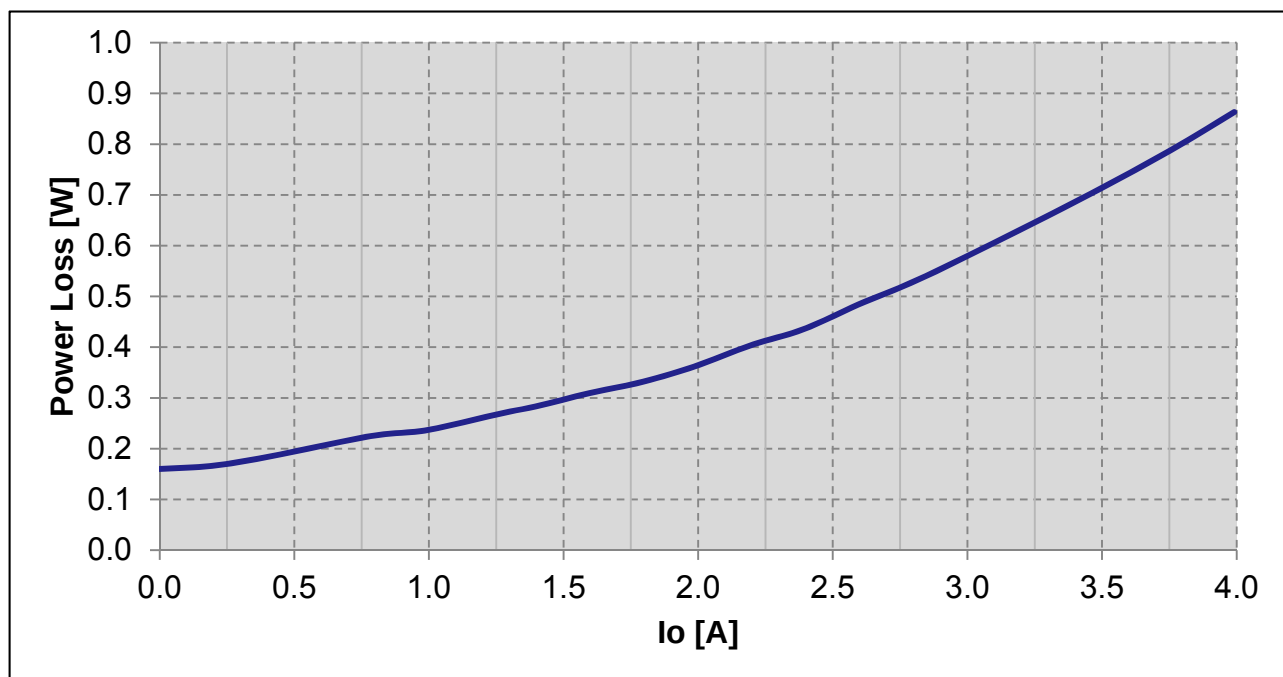
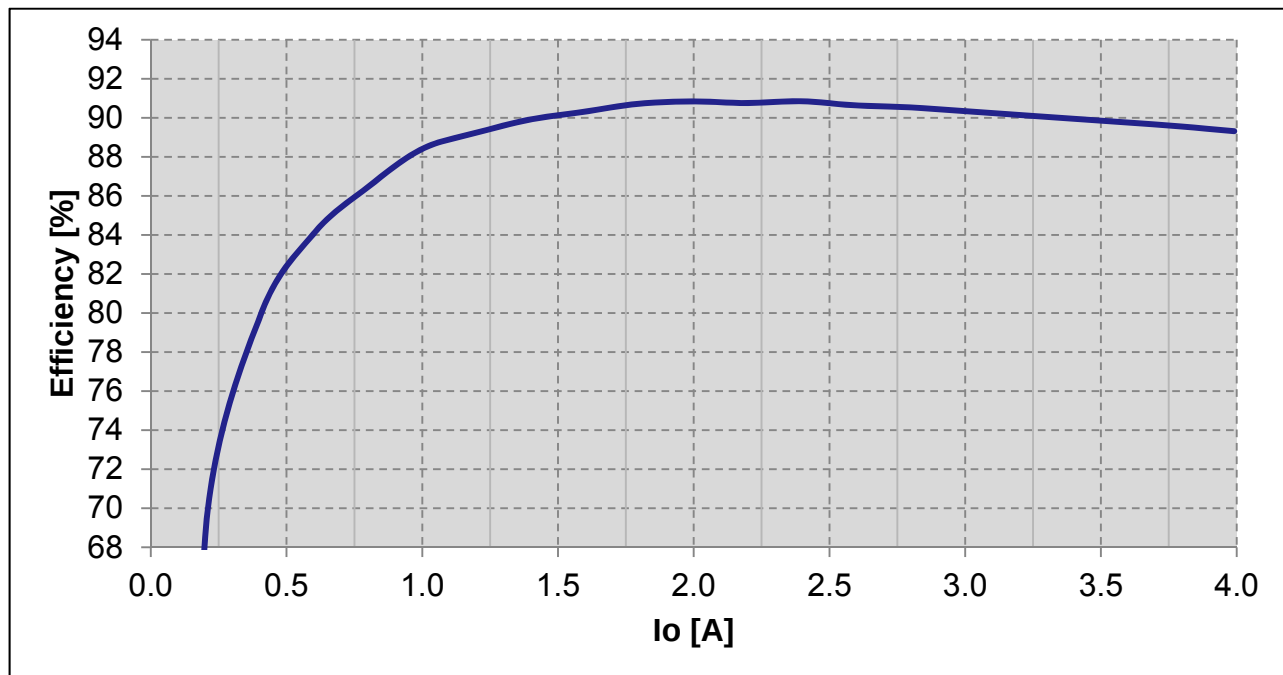


Fig.19: Efficiency and power loss vs. load current for channel1 ( $V_{out1} = 1.8V$ )

Efficiency and Power Loss of channel2

$V_{in}=12.0V$ ,  $V_{cc}/LDO=5.3V$ ,  $V_{out1}$  is disabled (EN1=low),  $V_{out2}=1.2V$ ,  $I_{o2}=0-4A$ , Room Temperature, No air flow

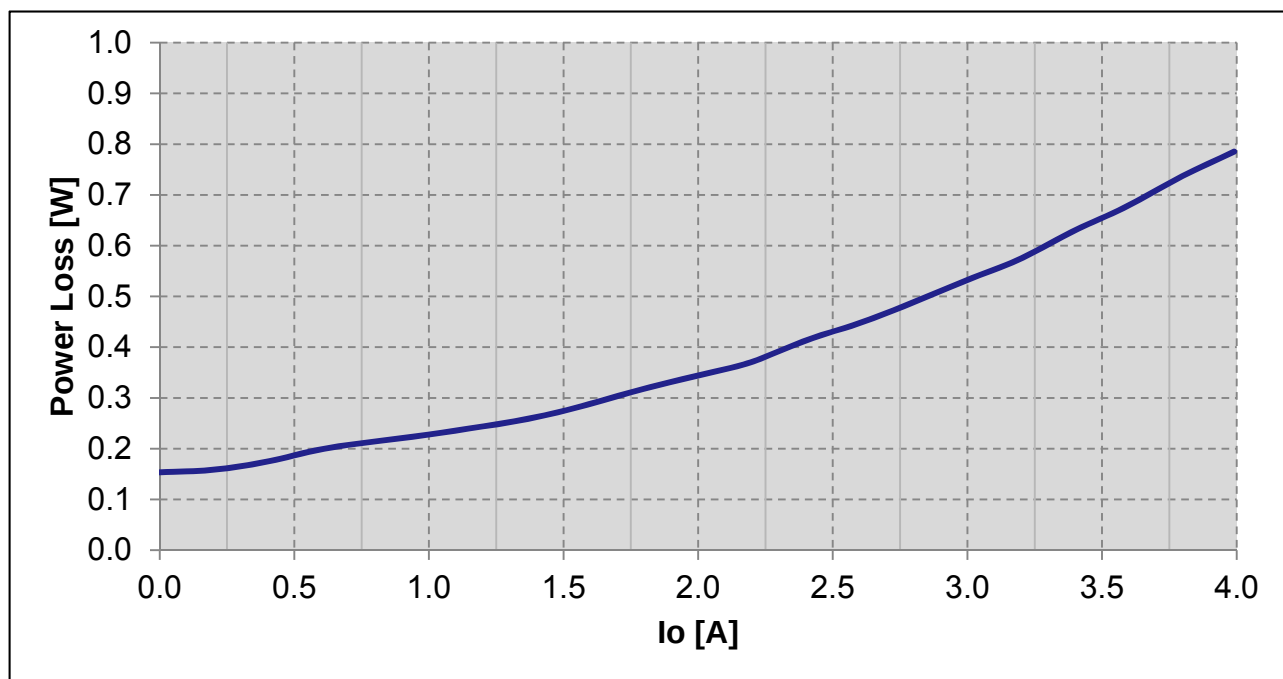
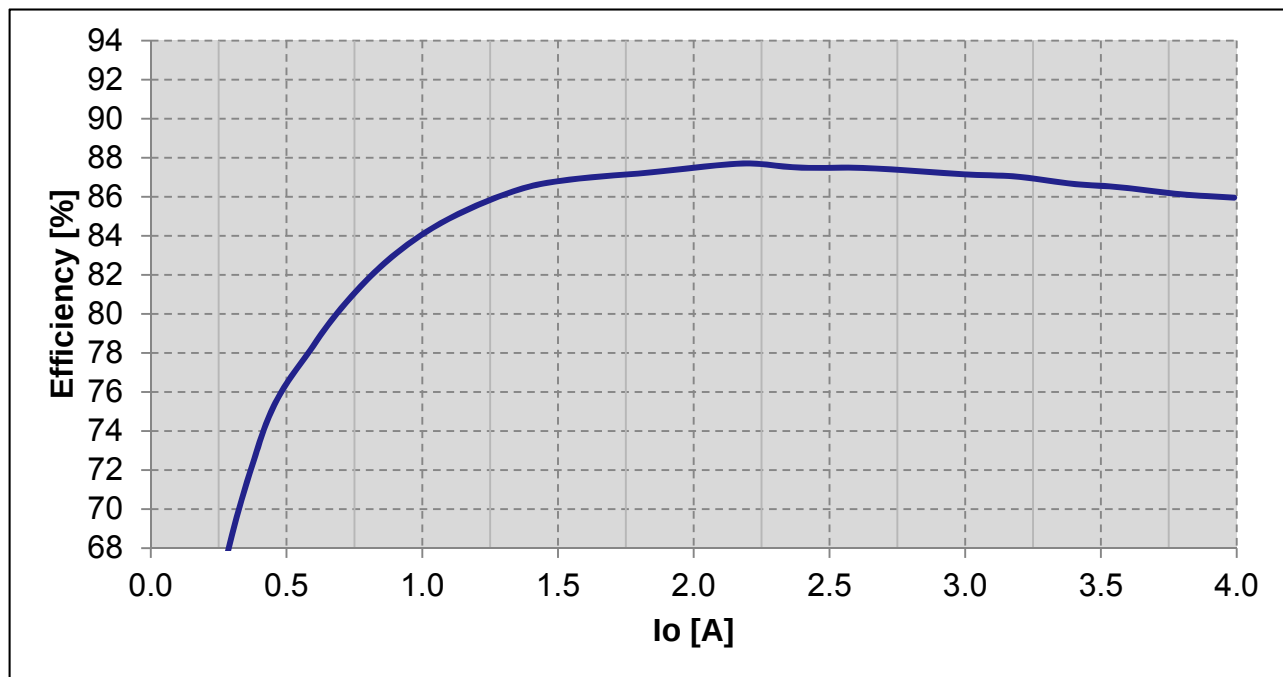


Fig.20: Efficiency and power loss vs. load current for channel2 ( $V_{out2} = 1.2V$ )

**Thermal Image**

Vin=12.0V, Vcc/LDO=5.3V, Vout<sub>1</sub>=1.8V, Vout<sub>2</sub>=1.2V, I<sub>o1</sub>= I<sub>o2</sub>=4A, Room Temperature, No air flow



Fig.21: Thermal Image at I<sub>o1</sub>=I<sub>o2</sub>=4A load  
Test Point 1: IR3891, Test Point 2: Inductor\_Ch1, Test Point 3: Inductor\_Ch2

The drawing consists of three views:
 

- TOP VIEW:** A square part with overall dimensions D (width) and E (height). A shaded square area in the bottom-left corner is labeled 'PIN 1 INDEX AREA'. Section lines A-A and B-B are shown.
- BOTTOM VIEW:** A detailed view of the underside of the part. It shows a central rectangular area with dimensions D4 and D3, and a width of L1. The height is divided into sections E2 and E4. Numerous features are numbered 1 through 31. A fillet radius of C0.3 is indicated at the bottom right corner.
- Detail View:** A magnified view of the 'PIN 1 INDEX AREA'. It shows a rectangular feature with width 'b' and height 'A'. The overall width of the detail is A3. A circular feature with diameter  $\varnothing 0.10$  is located at the bottom center, with a distance 'C' from the left edge and 'B' from the right edge.

**NOTES :**

1. DIMENSION AND TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. CONTROLLING DIMENSIONS : MILLIMETER. CONVERTED INCH DIMENSION ARE NOT NECESSARILY EXACT.

NOTES :

1. DIMENSION AND TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. CONTROLLING DIMENSIONS : MILLIMETER. CONVERTED INCH DIMENSION ARE NOT NECESSARILY EXACT.